

preparing a first polishing liquid containing tetravalent cerium ions in a first concentration;

adding a solvent to said first polishing liquid to form a second polishing liquid containing tetravalent cerium ions in a second concentration lower than the first concentration;

polishing a surface of a substrate containing Ru or a Ru compound in a surface region with the second polishing liquid,

wherein said addition of the solvent is carried out upon or immediately before the polishing of said substrate.

REMARKS

I. STATUS OF CLAIMS

Claims 11, 12, and 17-22 are pending. Claims 1, 4, and 5 have been cancelled without prejudice or disclaimer. Claim 17 has been amended to correct a minor typographical error found in the spelling of tetravalent. Applicants would like to thank the Examiner for bringing the typographical error to Applicants' attention. A marked-up version of claim 17 indicating the additions and deletions made in this amendment is found in the attached Appendix.

Applicants submit that the proposed amendment of claim 17 does not raise new issues or necessitate the undertaking of any additional search of the art by the Examiner, since all of the elements and their relationships claimed were either earlier

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claimed or inherent in the claims as examined. Therefore, this Amendment should allow for immediate action by the Examiner.

II. **CLAIM OBJECTION**

The Office has objected to claim 17 due to an informality. Applicants respectfully submit that the Office's grounds for rejection are rendered moot in view of the amendment to claim 17, which corrects the spelling of "tetravalent." Accordingly, Applicants respectfully request the withdrawal of this objection.

III. **REJECTIONS UNDER 35 U.S.C. § 102(e)**

A. **Claim 1**

The Office has maintained the rejections of claim 1 under 35 U.S.C. § 102(e) as anticipated by Westmoreland et al., U.S. Patent 6,143,192, "*Westmoreland*."

Applicants respectfully submit that the rejection of claim 1 under 35 U.S.C. §102(e) has been rendered moot in view of the cancellation of claim 1. Accordingly, Applicants respectfully request that the rejection of claim 1 under 35 U.S.C. §102(e) be withdrawn.

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B. Claims 11, 17-22

The Office has rejected claims 11, 17-22 under 35 U.S.C. § 102(e) as anticipated by *Westmoreland*.

The Office alleges that *Westmoreland* teaches a planarizing (polishing) method comprising removing Ru and or Ru dioxide using ceric ammonium nitrate that may be in the form of a first solution that is an aqueous solution wherein ceric ammonium nitrate and, optionally, other solutes are dissolved in liquid water. Office Action dated January 3, 2002, at 4. The Office specifically points to column 3, lines 42-49 of *Westmoreland* to teach the first polishing liquid. *Id.* The Office alleges that *Westmoreland* teaches a second polishing solution which is more dilute than the first solution by pointing to the following language at column 3, lines 55-57: "In one form, the material of the invention may include about 0.5 to about 70 weight percent ceric ammonium nitrate." *Id.*

Applicants respectfully traverse this rejection because *Westmoreland* does not teach all the elements of claims 11 and 17-22.

For a 35 U.S.C. § 102 rejection to be proper, a single prior art reference must contain every element of the claimed invention, including all claim limitations. See *Richardson v. Suzuki Motor Co.*, 868 F.2d 1226, 1236, 9 U.S.P.Q. 2d (BNA) 1913, 1920 (fed. Cir. 1989), cert. denied, 493 U.S. 853, 107 Ed. 2d (1989).

Claim 17 recites, *inter alia*, a polishing method comprising preparing a first polishing liquid containing tetravalent cerium ions in a first concentration, adding a solvent to said first polishing liquid to form a second polishing liquid, wherein said

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addition of the solvent is carried out upon or immediately before the polishing of said substrate.

Westmoreland does not teach or suggest addition of a solvent to a first polishing liquid upon or immediately before the polishing of the substrate. The passages relied upon by the Office to teach formation of the first and second solutions, specifically, column 3, lines 42-49 and 55-57, merely disclose alternative embodiments of *Westmoreland's* invention and not the specifically recited two solution system and polishing method of claim 17. *Westmoreland* teaches that the material of its invention may be in the form of a liquid etchant solution where the solution "... may be an aqueous solution wherein ceric ammonium nitrate and optionally, other solutes, are dissolved in liquid water." *Westmoreland*, col. 3, lines 42-48. Clearly, this language refers to only one liquid etchant solution that may comprise ceric ammonium nitrate and other solutes dissolved in water. *Westmoreland* further goes on to disclose that in one embodiment, the material of the invention may include about 0.5 to about 70 weight percent ceric ammonium nitrate. Col. 3, lines 54-56. Contrary to the Office's assertion, this language merely further defines the concentration range of ceric ammonium nitrate in *Westmoreland's* invention and does not teach a method of adding a solvent to said first polishing liquid to form a second polishing liquid, wherein said addition of the solvent is carried out upon or immediately before the polishing of said substrate as presently claimed.

None of *Westmoreland's* exemplified embodiments teaches or suggests a polishing method comprising preparing a first polishing liquid containing tetravalent

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cerium ions in a first concentration, adding a solvent to said first polishing liquid to form a second polishing liquid, wherein said addition of the solvent is carried out upon or immediately before the polishing of the substrate. However, these examples do teach use of a single bath used for etching purposes. There is simply nothing in *Westmoreland* to suggest dilution of its disclosed etching solutions prior to use. As such, *Westmoreland* fails to teach every recitation of claim 17. Therefore, the claim 17 is not anticipated by *Westmoreland* and Applicants respectfully request that this rejection be withdrawn.

Additionally, claim 17 is an independent claim. The Federal Circuit has held that if an independent claim is non-obvious under 25 U.S.C. § 103, then any claim depending therefrom is non-obvious as well. *In re Fine*, 837 F.2d 1071, 5 U.S.P.Q. 2d 1496 (Fed. Cir. 1988). Claims 11, and 18-22 are dependent on non-obvious independent claim 17. As such, claim 11, and 18-22 are non-obvious and patentable.

IV. REJECTION UNDER 35 U.S.C. § 103(a)

A. Claims 4 and 5

The Office has rejected claims 4 and 5 under 35 U.S.C. § 103(a) as obvious over *Westmoreland* as applied to claim 1. Office Action dated January 3, 2002, page 3.

Applicants respectfully submit that this rejection has been rendered moot in view of the cancellation of claims 4 and 5. Accordingly, Applicants respectfully request that this rejection be withdrawn.

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B. Claim 12

The Office has rejected claim 12 under 35 U.S.C. § 103(a) as obvious over *Westmoreland* as applied to claim 17. Office Action dated January 3, 2002, page 5. The Office alleges that *Westmoreland* only differs from claim 12 in failing to teach that the Ru compound is SrRuO₃. *Id.* The Office asserts that it would have been obvious to one of ordinary skill in the art to modify *Westmoreland* by replacing a Ru compound with a SrRuO₃ compound because they are seen as equivalent. *Id.*

Applicants respectfully traverse the claim 12 rejection on the basis that *Westmoreland* does not teach or suggest every limitation of claim 12.

In determining obviousness, 35 U.S.C. § 103 expressly requires consideration of the claimed invention "as a whole." For a prima facie case of obviousness, the Examiner must show some motivation for modifying the teachings of the references, and a reasonable expectation of success in doing so. *In re Vaeck*, 947 F.2d 488, 20 U.S.P.Q.2d 1438 (Fed. Cir. 1991). The mere fact that the prior art may be modified in the manner suggested by the Examiner does not make the modification obvious unless the prior art suggested the desirability of the modification. *In re Gordon*, 733 F.2d 900, 902, 221 U.S.P.Q. 1125, 1127 (Fed. Cir. 1984).

Claim 12 of the present invention recites, *inter alia*, a polishing method comprising, *inter alia*: preparing a first polishing liquid containing tetravalent cerium ions in a first concentration; adding a solvent to said first polishing liquid to form a second polishing liquid, polishing a surface of a substrate containing Ru or a Ru compound in a surface region with the second polishing liquid, wherein the addition of the solvent is

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carried out upon or immediately before the polishing of the substrate. Thus, claim 12 is directed to a polishing method using a diluted first polishing liquid. By contrast, *Westmoreland* discloses a removing method which does not teach an addition of a solvent upon or immediately before the polishing of the substrate. In addition, *Westmoreland* is directed to a planarization by etching rather than by polishing. This is evidenced by *Westmoreland*'s examples, which use high concentration solutions as well as the disclosure that the *Westmoreland* invention "... provides an advantageous alternative to existing ruthenium dry **etch** procedures." (emphasis added) *Westmoreland*, col. 4, lines 47-48.

Additionally, the comparative solutions disclosed in Example 1 of *Westmoreland* include the following etching solutions: aqua regia at 100°C, piranha solution at about 100°C, HCl/peroxide solution at about 85 °C, concentrated phosphoric acid solution at about 150 °C, an ammonium hydroxide/peroxide solution at about 100 °C, pure 100% bromine at room temperature, and 30% by weight potassium hydroxide solution at about 85 °C (*Westmoreland*, col. 7, lines 5 - 48). Examples 2 and 3 disclose use of room temperature baths of CR-14 Chrome Etchant (*Id.*, col. 7, line 60 to col. 8, line 1, and col. 8, lines 53-54, respectively). These solutions are clearly etchants.

In Example 2, the concentration of ceric ammonium nitrate used in the CR-14 Chrome Etchant is 30%. This is exceedingly high. A technique utilizing such a high concentration of ceric ammonium nitrate etches rather than polishes. If the entire surface of a substrate is polished with a composition containing such a high concentration of ceric ammonium nitrate, the midsection of the substrate will become recessed and dishing will occur. Dishing is detrimental in polishing applications.

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The present invention utilizes low concentrations of tetravalent cerium ions to polish a substrate without producing dishing effects. This is done by diluting the first polishing liquid with a solvent to obtain a low concentration of tetravalent cerium ions. *Westmoreland* does not mention or recognize the phenomenon of dishing, let alone a polishing method to reduce this undesirable phenomenon. As was discussed in section III (B) above, *Westmoreland* does not teach or suggest dilution of its etching solutions.

Also, the presently claimed invention recites that the addition of the solvent is carried out upon or immediately before the polishing of the substrate. This is done to ensure that the polishing liquid's oxidizing power is at its optimum strength. Applicants have shown the decay of oxidizing power in polishing liquids with low tetravalent cerium ion concentrations. Fig. 1 depicts Ru polishing rate as a function of time. The Ru polishing rate decreases as time progresses. At about the 48 hour mark, the Ru polishing rate is approximately one half of a newly prepared polishing solution. See Fig. 1.

Westmoreland is completely silent with regard to the time sensitivity of the oxidizing power and the subsequent instability of its etching solution. There is nothing in the *Westmoreland* disclosure to motivate one of ordinary skill to modify *Westmoreland's* etching process by first preparing a first polishing liquid containing tetravalent cerium ions in a first concentration; and then adding a solvent to said first polishing liquid to form a second polishing liquid, wherein the addition of the solvent is carried out upon or immediately before the polishing of the substrate. Nothing but the present application discloses this polishing process.

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However, it is impermissible hindsight to use the claimed invention as a guide through the maze of prior art disclosures, combining the right references in the right way so as to achieve the result of the claimed invention. See *Grain Processing Corp. v. American Maize-Products Corp.*, 840 F.2d 902, 5 U.S.P.Q.2d 1788 (Fed. Cir. 1988). There is simply nothing in *Westmoreland* to suggest the desirability of having a dilution step to form a second polishing liquid at or immediately prior to the polishing of the substrate as is presently claimed. One of ordinary skill in the art, armed with the teachings of *Westmoreland*, would simply not have been motivated to modify *Westmoreland's* etching solution in the manner suggested by the Office without benefit of the Applicants' own disclosure. As such, taken "as a whole," the prior art reference does not disclose or suggest the polishing method of claim 12 because not every claim limitation of claim 12 is taught or suggested by *Westmoreland*. Therefore, claim 12 is not obvious and is patentable.

In light of the foregoing, Applicants respectfully request the withdrawal of the rejection of claim 12 under 35 U.S.C. §103(a).

CONCLUSION

Applicants respectfully request that this Amendment under 37 C.F.R. § 1.116 be entered by the Examiner, placing claims 11, 12, and 17-22 in condition for allowance.

Furthermore, Applicants respectfully point out that the final action by the Examiner presented some new arguments as to the application of the art against

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Applicants' invention. It is respectfully submitted that the entry of the Amendment would allow the Applicants to reply to the final rejections and place the application in condition for allowance. Additionally, Applicants submit that the entry of the amendment would place the application in better form for appeal, should the Examiner dispute the patentability of the pending claims.

In view of the foregoing remarks, Applicants submit that this claimed invention, as amended, is neither anticipated nor rendered obvious in view of the prior art reference cited against this application. Applicants therefore request the entry of this Amendment, the Examiner's reconsideration and reexamination of the application, and the timely allowance of the pending claims.

Please grant any extensions of time required to enter this response and charge any additional required fees to our Deposit Account 06-0916.

Respectfully submitted,

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APPENDIX TO AMENDMENT OF April 3, 2002

Version with Markings to Show Changes Made

Amendments to the Claims

17. (Amended) A polishing method comprising:

preparing a first polishing liquid containing [teravalent] tetravalent cerium ions in a first concentration;

adding a solvent to said first polishing liquid to form a second polishing liquid containing tetravalent cerium ions in a second concentration lower than the first concentration;

polishing a surface of a substrate containing Ru or a Ru compound in a surface region with the second polishing liquid,

wherein said addition of the solvent is carried out upon or immediately before the polishing of said substrate.

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